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RESEARCH ARTICLE

Physico – Chemical Aspects of Pulliyankannu and Pulliyanthangal Lake Water in Ranipet, Vellore District, Tamilnadu, India

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ABSTRACT

The present study was designed to assess the nature and physico-chemical characteristics of water samples collected from Pulliyankannu and Pulliyanthangal Lake, Ranipet, Vellore Dt., Tamilnadu. The physico-chemical parameters studied were pH, turbidity, Total Dissolved solids (TDS), EC, alkalinity, total hardness, calcium, magnesium, Manganese, ammonia, nitrite, nitrate, chloride, fluoride, sulphate and phosphate. The results obtained showed a fluctuation in these parameters which gave an idea about the intensity of pollution caused by industrial and tannery effluents. Every parameter showed a significant correlation with increased lake water pollution. The results revealed that most of the water samples did not conform to BIS standards.

Key words: Pulliyankannu and Pulliyanthangal Lake, Vellore, groundwater, water pollution.

INTRODUCTION

Pollution is an undesirable change in physical, chemical or biological characteristic of air, land and water that harmfully affects human life (Odum, 1971). Water is the elixir of life, a precious gift of nature to mankind and millions of other species living on the earth. It is fast becoming a scare commodity in most parts of the world (Usharani *et al.*, 2010).

Human beings, rural or urban dispose wastes in such a manner that it affects the normal functioning of ecosystem. Population explosion, urbanization, industrialization and human apathy significantly contribute towards "ecological disaster". Rapid industrialization requires water not only for consumption but also for the discharge of effluent. A natural ecosystem other than oceans has been ruthlessly exploited for human benefits (Srinivas *et al.*, 2009).

Water is essential to all forms of life in the world. Water is an indispensible natural resource on earth. Water is an essential element for humankind, animals and plants. It is also an important element of the aquatic environment, the natural habitat of multiple species (Kumaresan and Riyazuddin, 2008), where its quality plays a determining role in their protection and conservation. All our activities depend on stable water. Water is an essential requirement of human and industrial development and is also one of the most delicate parts of the environment (Das and Acharya, 2003).

Although industrialization is inevitable, various devastating ecological and human disasters which have continuously occurred over the last four decades, implicate industries as major contributors to environmental degradation and pollution problems of various magnitude (Fayemiwo *et al.*, 2011). Many authors have conducted studies regarding the physicochemical characteristics of water of industrial areas and have concluded that it is the high rate of exploration than its recharge, inappropriate dumping of solid as well as liquid wastes, lack of strict enforcement of law and loose governance are the causes of deterioration of ground water quality (Sandeep *et al.*, 2008; Mahananda *et al.*, 2010).

MATERIALS AND METHODS

Study area

The Ranipet town is located at 12.56^{o} Northern latitude and 79.20^{o} eastern longitude of Chennai. Ranipet is an industrial town on the Chennai – Bangalore highway, 130 kms away from Chennai. It is geographically 25 Km away from the north east of Vellore head quarters.

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Palar River is one of the major water sources for drinking and draining purpose. The River runs from west to east and at its downstream an industrial complex and two major water bodies namely Pulliyankannu and Pulliyanthangal Lake are located.

Ecologically, Ranipet is the most strategic place where many industries started mushrooming. The development of industries contaminates the aquatic sources which in turn affects the water quality.

SAMPLES FOR EXPERIMENT

The water samples were collected from Pulliyankannu and Pulliyanthangal lake, Ranipet, Vellore Dt., Tamilnadu, India. The present investigation was carried out to study the physico-chemical characteristics of lake water.

WATER SAMPLES

Water samples were collected for one year covering four seasons (Summer, Pre monsoon, Monsoon and Post monsoon) from September 2011 to August 2012. One litre sterilized containers were used to collect water samples for analysis of physico-chemical parameters at five different stations in the each lake and agriculture area. All the containers were kept in an ice-box for laboratory analysis. Physico-chemical parameters (turbidity, TDS, EC, pH, alkalinity, hardness, calcium, magnesium, ammonia, nitrite, nitrate, chloride, fluoride, sulphate and phosphate) were measured in-situ and in the laboratory following the standard methods (APHA 1998; APHA, 2005).

RESULTS AND DISCUSSION

For the present study the water samples collected from Pulliyankannu and Pulliyanthangal lakes were analyzed for physico chemical parameters and heavy metals such as appearance, odour, turbidity, Total dissolved solids (TDS), Electrical conductivity (EC), pH, alkalinity, hardness, calcium, magnesium, ammonia, nitrite, nitrate, chloride, fluoride, sulphate, phosphate contents were estimated using standard methods as given in APHA (2005). The acceptable limit mentioned in the work represents the standard for drinking water quality specified by BIS. The aim of the present study was to assess the influence of tannery and industrial effluent discharge in Puliyankanu and Pulliyanthangal lakes of Ranipet area, Vellore district. The concentration of physico chemical parameters from maximum to minimum according to seasons was in the following order of summer> winter> monsoon> post monsoon.

The seasonal average of the turbidity of the Pulliyankannu lake waters during winter, summer, monsoon and post monsoon periods were periods were 18±3.2, 22±2.4, 20±3 and 21±3.4 respectively and annual average was 20.25±3 (Table:1). The turbidity level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 19±4, 22±2, 17±3 and 17±4 respectively, and annual average was18.75±3.25 (**Table 2**). The colour of the water was yellow and turbid. The colour or appearance may be a result of the presence of natural metallic ions like manganese, human and peat material. The result showed that the values of turbidity were higher than the permissible limit. The turbidity of the effluent might be due to the discharge of high concentrations of carbonate, bicarbonate, chloride, calcium, magnesium and sodium which are used in tanning industries (Chakrapani, 2005).

Electrical conductivity (EC) seasonal average during winter, summer, monsoon and post monsoon periods were periods were 1,154±44, 1,288±31, 996±61 and 909±26 respectively and annual average was 1,086±40.5 (Table1). The Electrical conductivity level in Pulliyanthangal lake during the four seasons winter, summer, monsoon and post monsoon periods were 879±22, 989±25, 871±78 and 820±61respectively and annual average was 889.75±46.5 (Table 2). The result showed that the values of Electrical conductivity were higher than the permissible limit. The higher Electrical conductivity (EC) alters the chelating properties of water bodies and creates an imbalance of free metal availability for flora and fauna (Akan *et al.,* 2008).

The seasonal average of total dissolved solids (TDS) content of the Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 2,897±72.2, 3,493±83.4, 3,054±22.5 and 2,296±22.1 respectively, and annual average was 2,935±50 (**Table 1**). The TDS level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 2,056±128, 2,232±143, 1,876±87 and 1,800±67 respectively and annual average was 1,991±106.2 (Table 2). The result showed that the values of TDS were higher than the permissible limit (all in mg/l). The high levels of TDS induce

eutrophication. The eutrophication can often cause extensive algal growth or "blooms" that can choke freshwater systems by filling the stream with aquatic vegetation and demanding excessive oxygen during the night. Total dissolved solids are mainly due to carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, nitrogen, calcium, sodium, potassium and iron (Kannan *et al.,* 2009). In the liming section of tanning process, protein, hair, skin and emulsified fats are removed from the hides, which are released in the effluent and therefore increase the total solids (Bhalli and Khan, 2006).

The seasonal average pH values in Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 7.45±2.5, 8.87±1.8, 7.69±2.1 and 7.98±1.6 respectively, and annual average was 7.99±2 (Table 1). The pH level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were was 7.43±0.56, 8.13±1.23, 7.78±0.54 and 7.12±0.87 respectively, and annual average was 7.615±0.8 (Table 2). The result showed that the values of pH were higher than the permissible limit. While high levels of either acidity or alkalinity can destroy life, environmental groups are most concerned about acid levels. Harmful acidic water can come from both acid rain and acidic mine drainage.

Seasonal average alkalinity value of the Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were periods were 624±34, 687±61, 638±25 and 612±43 respectively and annual average was 640.25±40.75 (Table 1). The alkalinity level in Pulliyanthangal lake water during to four seasons winter, summer, monsoon and post monsoon periods were 612±22, 641±43, 598±32 and 567±28 respectively, and annual average was 604.5±31.25 (Table 2). The result showed that the values of alkalinity were higher than the permissible limit (all in mg/l). Excess alkalinity in an ecosystem can reduce the ecosystem's ability to sustain life.

Average seasonal hardness value of the Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were periods were 1,500±25.5, 1,622±27, 1,077±21.3 and 987±13.4 respectively, and annual average was 1,296.5±21.8 (Table 1). The hardness level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 954±55, 1,032±89, 876±72 and 765±29 respectively, and annual average was 906.5±61.25 (Table:2). The result showed that the values of hardness were higher than the permissible limit (all in mg/l). Hardness is one of the very important properties of water from a utility point of view for different purposes. It is a well known fact that hardness is not caused by a single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations, although cations like barium, iron, manganese, strontium and zinc also contribute (Chaudhary *et al.,* 2005).

The average seasonal calcium (Ca) value of the Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were periods 371±55, 376±52, 354±54 and 298±22 respectively, and annual average was 349.75±45.75 (Table 1). The calcium level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 223±12, 262±15, 213±21 and 198±8 respectively, and annual average was 224±14 (Table 2). The result showed that the values of Ca were higher than the permissible limit (all in mg/l). Calcium and magnesium precipitate the soap, forming a curd which causes "bathtub ring" and dingy laundry (yellowing, graying, loss of brightness, and reduced life of washable fabrics), and feels unpleasant on the skin (red, itchy, or dry skin) (Acharya *et al.,* 2008).

The average seasonal magnesium (Mg) value of the Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 162±12, 173±14, 134±17 and 115±22 respectively, and annual average was 146±16.25 (Table 1). The Mg level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 162±31, 173±43, 134±15 and 115±21 respectively, and annual average was 146±27.5 (Table 2). The result showed that the values of Mg were lower than the permissible limit (all in mg/l).

The seasonal average ammonia (NH_3) value of the Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 0.86±0.12, 0.97±0.14, 0.78±0.11 and 0.25±0.17 respectively, and annual average was 0.715±0.14(Table 1). The ammonia level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 0.97±0.09, 0.78±0.13, 0.25±0.08 and

0.86±0.21 respectively, and annual average was 0.715±0.33 (Table 2). The result showed that the values of ammonia were higher than the permissible limit (all in mg/l).

The seasonal average nitrite (NO_2) value of the Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 0.07±0.01, 0.09±0.02, 0.04±0.02 and 0.05±0.01 respectively, and annual average was 0.062±0.015 (Table:1). The NO_2 level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 0.07±0.01, 0.09±0.02, 0.05±0.02 and 0.04±0.01 respectively, and annual average was 0.0625±0.015 (Table:2). The result showed that the values of NO_2 were higher than the permissible limit (all in mg/l).

In Pulliyankannu lake water the seasonal average nitrate (NO_3) value of during winter, summer, monsoon and post monsoon periods were 61±12, 83±14, 67±15 and 48±12 respectively, and annual average was 64.75±13.25 (Table:1). The nitrate level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 71±9, 83±12, 70±14 and 67±7 respectively, and annual average was 72.75±10.5 (Table:2). The result showed that the values of NO_3 were higher than the permissible limit (all in mg/l). Humans are subject to nitrate and nitrite toxicity, with infants being especially vulnerable to methemoglobinemia due to nitrate metabolizing triglycerides present at higher concentrations than at other stages of development. Methemoglobinemia in infants is known as blue baby syndrome (Knobeloch *et al.*, 2000).

The seasonal average chloride (Cl^-) levels in Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were periods were 1,072±22.5, 1,120±12.7, 1,003±56 and 968±78 respectively, and annual average was 1,040.75±42.3 (Table 1). The chloride level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 1,032±38, 1,140±54, 968±15 and 923±18 respectively, and annual average was 1,020.75±31.25 (Table 2). The result showed that the values of chloride were higher than the permissible limit (all in mg/l). The initial effect of consuming high levels of sodium chloride is water retention, as cells trap water to try to restore an optimal balance of electrolytes. It may also experience digestive upset, but, provided we drink plenty of water, healthy kidneys can remove the excess salt accumulation. Symptoms of toxicity can include dizziness, changes in blood pressure, abnormal heartbeat, convulsions, coma and eventual death.

The seasonal average fluoride (F) level in Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 0.6±0.02, 0.7±0.02, 0.4±0.01 and 0.4±0.01 respectively, and annual average was 0.52±0.015 (Table:1). The F level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 0.63±0.1, 0.71±0.2, 0.64±0.01 and 0.54±0.01 respectively, and annual average was 0.63±0.012 (Table:2). The results showed that the values of Fluoride were lower than the permissible limit (all in mg/l). Fluoride enters the body through food, water, industrial exposure, drugs and cosmetics. Presence of fluoride in water may affect the photosynthesis, respiration and protein synthesis and enzyme activities of higher plants (Sarala and Rao, 1993).

The seasonal average sulphate (SO_4) level in Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 449±32, 454±24, 432±12 and 392±45 respectively, and annual average was 432±28.25 (Table 1). The SO_4 level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 429±44, 444±42, 432±21 and 382±12 respectively, and annual average was 421.75±30 (Table 2). The result showed that the values of SO_4 were higher than the permissible limit (all in mg/l).

The seasonal average phosphate level in Pulliyankannu lake water during winter, summer, monsoon and post monsoon periods were 0.19±0.06, 0.27±0.09, 0.09±0.02 and 0.08±0.02 respectively, and annual average was 0.157±0.048 (Table 1). The PO_4 level in Pulliyanthangal lake water during the four seasons winter, summer, monsoon and post monsoon periods were 0.16±0.04, 0.27±0.07, 0.17±0.12 and 0.16±0.09 respectively, and annual average was 0.2±0.08 (Table 2). The result showed that the values of PO_4 were lower than the permissible limit (all in mg/l).

Table 1: Physico-Chemical Parameters In Pulliyankannu Lake Water

Physico-chemical parameters	Winter	Summer	Monsoon	Post monsoon	Annual average Mean	BIS	% of changes
Appearance	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Clear	
Odour	Objectionable	Objectionable	Objectionable	Objectionable	Objectionable	Agreeable	
Turbidity NTU	18±3.2	22±2.4	20±3	21±3.4	20.25±3	10	102.5
Total dissolved solids	2,897±72.2	3,493±83.4	3,054±22.5	2,296±22.1	2,935±50	2,000	46.75
EC mic mho/cm	1,154±44	1,288±31	996±61	909±26	1,086±40.5	300	262
pH	7.45±2.5	8.87±1.8	7.69±2.1	7.98±1.6	7.99±2	6.5-8.5	14.14
Alkalinity	624±34	687±61	638±25	612±43	640.25±40.75	600	6.70
Hardness	1,500±25.5	1,622±27	1,077±21.3	987±13.4	1,296.5±21.8	600	111.58
Calcium(Ca)	371±55	376±52	354±54	298±22	349.75±45.75	200	74.87
Magnesium (Mg)	162±12	173±14	134±17	115±22	146±16.25	150	-2.66
Ammonia (NH_3)	0.86±0.12	0.97±0.14	0.78±0.11	0.25±0.17	0.715±0.14	0.5	43
Nitrite (NO_2)	0.07±0.01	0.09±0.02	0.04±0.02	0.05±0.01	0.062±0.015	0.02	210
Nitrate (NO_3)	61±12	83±14	67±15	48±12	64.75±13.25	45	43.88
Chloride (Cl^-)	1,072±22.5	1,120±12.7	1,003±30	968±54	1,040.75±29.8	1,000	4
Fluoride (F)	0.6±0.02	0.7±0.02	0.4±0.01	0.4±0.01	0.52±0.015	1.5	-65.33
Sulphate (SO_4)	449±32	454±24	432±12	392±45	432±28.25	400	8
Phosphate (PO_4)	0.19±0.06	0.27±0.09	0.09±0.02	0.08±0.02	0.157±0.048	1	-84.3

Values are mean of six individual observations in each group ± S.D. 'P' <0.05 denotes statistical significance, '+' and '-'indicate % of changes over the normal groups. All parameters measured in mg/l, except pH, EC (mic mho/cm) and turbidity (NTU).

Table 2: Physico-Chemical Parameters In Pulliyanthangal Lake Water

Physico-chemical parameters	Winter	Summer	Monsoon	Post monsoon	Annual average Mean	BIS	% of changes
Appearance	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Clear	
Odour	Objectionable	Objectionable	Objectionable	Objectionabl	Objectionable	Agreeable	
Turbidity NTU	19±4	22±2	17±3	17±4	18.75±3.25	10	87.5
Total dissolved solids	2,056±72	2,232±84	1,976±87	1,800±67	2,016±76	2,000	0.8
EC mic mho/cm	879±22	989±25	871±78	820±61	889.75±46.5	300	196.58
pH	7.43±0.56	8.13±1.23	7.78±0.54	7.12±0.87	7.615±0.8	6.5-8.5	8.78
Alkalinity	612±22	641±43	598±32	567±28	604.5±31.25	600	0.75
Hardness	954±55	1,032±89	876±72	765±29	906.5±61.25	600	51.08
Calcium(Ca)	223±12	262±15	213±21	198±8	224±14	200	12
Magnesium (Mg)	162±31	173±43	134±15	115±21	146±27.5	150	-2.66
Ammonia (NH_3)	0.97±0.09	0.78±0.13	0.25±0.08	0.86±0.21	0.715±0.33	0.5	43
Nitrite (NO_2)	0.07±0.01	0.09±0.02	0.05±0.02	0.04±0.01	0.0625±0.015	0.02	212.5
Nitrate (NO_3)	71±9	83±12	70±14	67±7	72.75±10.5	45	61.66
Chloride (Cl^-)	1,032±38	1,140±54	968±15	923±18	1,020.75±31.2	1,000	2.07
Fluoride (F)	0.63±0.1	0.71±0.2	0.64±0.01	0.54±0.01	0.63±0.012	1.5	-58
Sulphate (SO_4)	429±44	444±42	432±21	382±12	421.75±30	400	5.43
Phosphate (PO_4)	0.16±0.04	0.27±0.07	0.17±0.12	0.16±0.09	0.2±0.08	1	-80

Values are mean of six individual observations in each group ± S.D. 'P' <0.05 denotes statistical significance, '+' and '-'indicate % of changes over the normal groups. All parameters measured in mg/l, except pH, EC (mic mho/cm) and turbidity (NTU).

CONCLUSIONS

People living in high-density, low-income settlements in developing countries lack efficient sanitation and drainage systems. This includes improper disposal of sewage, industrial effluents and severely contaminated storm water runoff. In low-income areas, the paths are often merged; sewage, industrial effluents, solid waste and contaminated runoff enter surface drains. This in turn eventually runs into lakes, ponds, rivers and impoundments that are used for drinking water supply. Hence, discharges from these settlements cause numerous adverse water quality effects on urban areas. These problems reflect the poor conditions with respect to the climate, economic development, the level of environmental protection practice (including the associated infrastructures), institutional arrangements and public awareness. The planners and engineers are not equipped with the necessary knowledge and tools to deal with environmental quality problems

especially in informal settlements. Government has to ensure that industries make use of standard waste treatment plants for the treatment of their wastes before discharging them into water bodies. Also, various awareness campaigns, workshops need to be organized and rallies must be conducted regularly to highlight important environmental issues.

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